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Title: (U) LNK3DNT Capability in SENSMG

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SUBJECT: (U) LNK3DNT Capability in SENSMG

I. Introduction

The SENSMG multigroup neutron sensitivity code[1,2] has been extended to read materials and geometry from `redoin` and `lnk3dnt` files written by the PARTISN multigroup discrete ordinates code[3] or the MCNP6 Monte Carlo code.[4] This report describes the user interface for this capability and the code verification that was done.

Not all of the capability of SENSMG is available for `redoin`/`lnk3dnt` inputs. The only responses allowed are k_{eff} or α eigenvalues. Fixed-source problems are not allowed, and there is no mechanism to input reaction rates or reaction-rate ratios.

The next section of this report describes the user interface. Section III describes the verification of the capability. Section IV is a summary and conclusions. The input files used for verification are listed in the appendix.

II. User Interface

There are now two input file options for SENSMG: All materials and geometry are specified in one input file,[1,2] or materials and geometry are specified in PARTISN `redoin` and `lnk3dnt` files. This report describes the latter option.

The `redoin` and `lnk3dnt` are files written by PARTISN and/or MCNP6 in a previous run. For SENSMG, the `redoin` file can have any name, and that is the file name specified with the `-i` parameter on the command line.[2] SENSMG recognizes it as a `redoin` file because the first line is that of a PARTISN input in NAMELIST format: It has five one-digit integers each preceded by five spaces (Fortran 5I6 format), and the fourth integer is 1 (NPASS in the PARTISN manual[3]). Once SENSMG recognizes a `redoin` file, it expects to find a `lnk3dnt` file. The `lnk3dnt` file must be named "lnk3dnt" but it can be a symbolic link to a file with a different name.

The `redoin` file has the geometry type (slab, sphere, or cylinder) as `igeom` in block 1; the number of radial and axial coarse meshes as `im` and `jm`, respectively, in block 1; the number of materials as `mt` in block 1; LIBNAME as `libname` in block 3; the number of isotopes as `matls_size` in block 4; the materials and isotopes in the correct order in block 4; and the type of calculation (i.e., eigenvalue or fixed-source) as `ievt` in block 5.

If materials are specified in the `redoin` file rather than the `lnk3dnt` file, then the `matls` keyword in block 4 should have all materials in order, all isotopes given by weight fraction (specified as `wtfrac` on the `matspec` keyword), and mass densities given with the `assign` keyword. If materials are specified in the `lnk3dnt` file rather than the `redoin` file, then the `matls` keyword in block 4 should have one isotope per material, with its density given as 1, and `assign="matls"` (including the quotation marks). In both cases, material names must be given as `mNNNNNN` and zone names as `znNNNNNN`, where NNNNNN is at most a six-digit material number (fewer digits can be used). SENSMG does not have the generic input parser that PARTISN has.

MCNP6 can write regular PARTISN input files (not `redoin` format) and `lnk3dnt` files.[4] To convert MCNP6's PARTISN input `partinp` to the correct format, run it with PARTISN and modify the resulting `redoin` file by replacing block 4, which will be in atom fraction, with the equivalent material definitions defined by weight fraction. Ensure that the number of `matspec` entries is equal to the number of materials and that they are all the same (`wtfrac`). Set mass densities to 1 on the `assign` keyword (because the `lnk3dnt` file has the actual material densities).

SENSMG is not set up to run a `lnk3dnt` file that specifies more than one fine mesh per coarse mesh unless there is also only one material (usually comprising multiple isotopes) specified in each fine mesh. In this case, SENSMG accepts the `redoin`/`lnk3dnt` input but treats it like a regular input, after it checks to ensure that every coarse mesh has only one material (all fine meshes within each coarse mesh have the same material). This is the type of `lnk3dnt` file that PARTISN writes when `wrlnk3d=1` in block 1.

The number of groups, number of angles, scattering order, etc. are also present in the `redoin` file but these are ignored (except that warnings are issued if they differ from the SENSMG command-line inputs[2]).

The `redoin` file need not have "`fmmix = 1`" in block 1 to tell PARTISN to read the geometry and materials from the `lnk3dnt` file.[3] That keyword is written to SENSMG's PARTISN input file.

The `lnk3dnt` file is a binary file that contains the geometry specifications and the material in each mesh.[3]

The `redoin`/`lnk3dnt` capability is only implemented for k_{eff} or α eigenvalue problems. If `ievt` = 0 in the `redoin` file, specifying a fixed-source problem to PARTISN, SENSMG will do an α eigenvalue problem instead. There is presently no way to specify reaction-rate ratios using this capability.

To reiterate, the `redoin`/`lnk3dnt` capability is invoked from the format of the first line of the input file. This slightly limits the type of title that can be used in a regular SENSMG input file.[2]

III. Verification

III.A.1. Test Problem

A two-dimensional cylindrical problem with three materials was used for verification. The geometry is based on a measurement that was performed at Oak Ridge National Laboratory.[5] A polyethylene bottle containing depleted uranium (DU) in nitric acid solution was shielded by an aluminum disk from a high-purity germanium gamma-ray detector aimed at the bottom of the bottle. The detector was not modeled. In the experiment, the solution density was close to 1 g/cm^3. Here it is a factor of 10 larger to aid debugging. The materials are defined in Table I and dimensions are shown in Figure 1.

This experiment measured gamma rays and was used as a test problem for uncollided gamma rays in Ref. 6. Here we use the system's k_{eff}, which is not physically meaningful, as the response, and we intentionally don't converge the transport solution very tightly. Differences in calculations should be magnified.

All input files were run with S_{16} quadrature, P_3 scattering, and a convergence criterion (PARTISN's `epsi`) of 1E-3. These parameters were set on the input line. For test problems 1 and 3, PARTISN

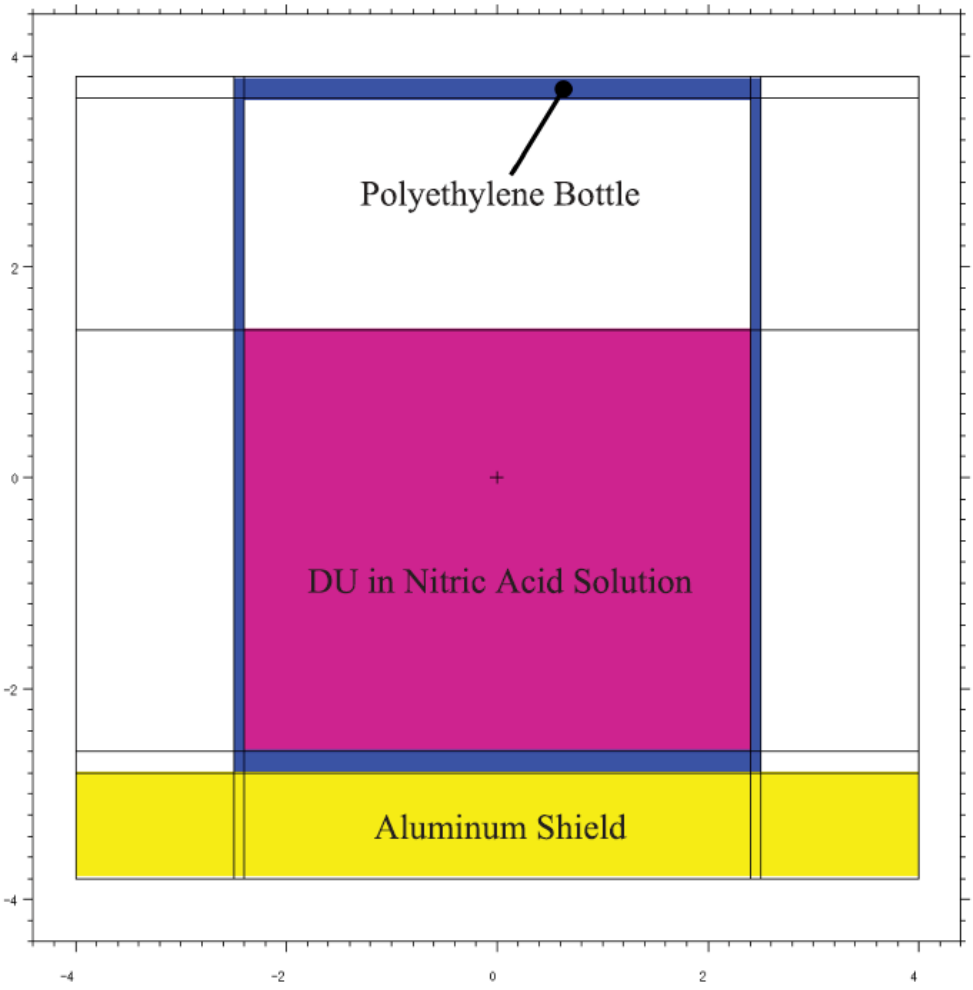

Figure 1. Cross-section (*r*-*z*) of the cylindrical geometry. Scales in centimeters. From Ref. 6.

Table I. Materials in the Cylindrical Test Problem.[(a)]

Index	Material	Composition (Weight Fraction)	Density (g/cm^3)
1	DU in Nitric Acid	^{235}U 0.000033959; ^{238}U 0.00996604; ^{16}O 0.883106; ^{1}H 0.106894	10.25[(a)]
2	Polyethylene	^{1}H 0.143716; C 0.856284	0.93
3	Aluminum	^{27}Al 1.	2.7

(a) This material had a density of 1.025 g/cm^3 in Ref. 6.

version 8.29 was used with 24 processors. For test problem 2, a very old version, 5.97, was used in order to work around a bug; see Sec. III.A.4.

SENSMG's new `redoin`/`lnk3dnt` capability was verified by ensuring that the sensitivities computed using it are identical to those computed using a regular SENSMG input (as defined in Refs. 1 and 2).

III.A.2. Procedure for Test 1

Results of the `redoin`/`lnk3dnt` capability were compared with those from a regular SENSMG input that specified the problem as normal, with materials defined in coarse meshes as shown in Figure 1. The `redoin` and `lnk3dnt` files written by PARTISN from the regular SENSMG input were used. Sensitivities from both inputs should be identical.

The procedure was as follows:

1. Run the initial, regular SENSMG input file to completion. Save all output.
2. Save the `redoin` file and modify it as follows:
    a. Remove the entries in "`&block_2`" (leaving "`&block_2`").
    b. Remove the entries in "`&block_2_arrays`" (leaving "`&block_2_arrays`").

    Note that the resulting file is not a legitimate PARTISN input file, but it is good enough because. SENSMG reads it and constructs from it a legitimate PARTISN input file. Adding "`fmmix=1`" to block 1 is all that is needed to make a legitimate PARTISN input file.
3. Run the forward PARTISN input file associated with the original SENSMG run and write a `lnk3dnt` file from it by adding "`wrlnk3d=1`" to block 1. Save the new `lnk3dnt` file.
4. Run to completion SENSMG with the `redoin` file modified in step 2 and the `lnk3dnt` file created in step 3.
5. Compare the cross section sensitivities in `sens_k_x` from steps 1 and 4. They should be identical.
6. Compare surface derivatives in `sens_k_r` from steps 1 and 4 for the boundaries between materials and the outer boundary. They should be identical.
7. Compare some of the mass density sensitivities in `sens_k_r` from steps 1 and 4. They should be identical.

In this procedure, there were two input files run in SENSMG.

The input file run in step 1 is listed in the appendix. It was run with 10 fine meshes in each coarse mesh in each direction. These were set by modifying the source code for this test. The goal was to run quickly, not accurately.

The `redoin` file as modified in step 2 is listed in the appendix.

III.A.3. Results for Test 1

Both input files gave exactly the same k_{eff}, 3.3626593E-03.

Comparing the cross-section sensitivities from the regular SENSMG input and the `redoin`/`lnk3dnt` input (step 5), they are identical except for differences in the sum of the chi sensitivities that are supposed to be zero but are numerically only very small (e.g. 9E-17). The individual group components of the chi sensitivities are all identical.

Comparing the surface derivatives from the regular SENSMG input and the `redoin`/`lnk3dnt` input (step 6), they are identical.

Comparing the mass density sensitivities from the regular SENSMG input and the `redoin`/`lnk3dnt` input (step 7), they are identical.

III.A.4. Procedure for Test 2

Results of the `redoin`/`lnk3dnt` capability generated from MCNP6.2 were compared with those from a regular SENSMG input that specified the problem as normal. The MCNP6.2 mesh had one coarse mesh in each direction, 10 fine meshes in the radial direction, and 20 fine meshes in the axial direction (MCNP6's `lnk3dnt` file sets the number of coarse meshes to the number of fine meshes). The fine meshes are shown in Figure 2. Comparing Figure 2 with Figure 1 shows that the mesh in this test causes materials to mix. The regular SENSMG input used the mesh of Figure 2. Sensitivities from both inputs should be identical.

The procedure was as follows:

1. Run the MCNP6 input file listed in the appendix using MCNP6's "im" execution options to write a PARTISN input file and `lnk3dnt` file. Save the files.
2. Modify the PARTISN input file created in step 1 as follows:
    a. Replace all of block 4 with the material compositions defined by weight fraction, using unity for the mass densities on the `assign` keyword.
    b. In block 5, add "`nofxup=1 iitl=0`". These keywords are not recognized by MCNP6 (but they should be).
3. Run the PARTISN input file created in step 2. Save the resulting `redoin` file.
4. Run to completion SENSMG with the `redoin` file created in step 3 and the `lnk3dnt` file created in step 1. Save all output.
5. Run SENSMG with the `redoin` file created in step 3 and the `lnk3dnt` file created in step 1 and write a regular SENSMG input file from its data using subroutine wrsensmg called from the main program, sensmg. The new SENSMG input file is called `tmp_sensmg_inp`. Save it.
6. Run to completion SENSMG with the input file created in step 5. Save all output.
7. Compare the cross section sensitivities in `sens_k_x` from steps 4 and 6. They should be identical.
8. Compare surface derivatives in `sens_k_r` from steps 4 and 6 for the boundaries between materials and the outer boundary. They should be identical.

9. Compare the mass density sensitivities in `sens_k_r` from steps 4 and 6. They should be identical.

In this procedure, there were two input files run in SENSMG. The MCNP6 input file run in step 1 is listed in the appendix. The PARTISN input file run in step 3 is listed in the appendix.

The regular SENSMG input file created in step 5 is 151 lines long. It is not listed in the appendix. It was run with 1 fine mesh in each coarse mesh in each direction. These were set by modifying the source code for this test.

While the `redoin` file was created using PARTISN version 8 in step 3, when it was run in SENSMG, PARTISN version 5.97 was used. There is a bug in PARTISN version 8 that causes repeated isotopes in a material to be ignored.

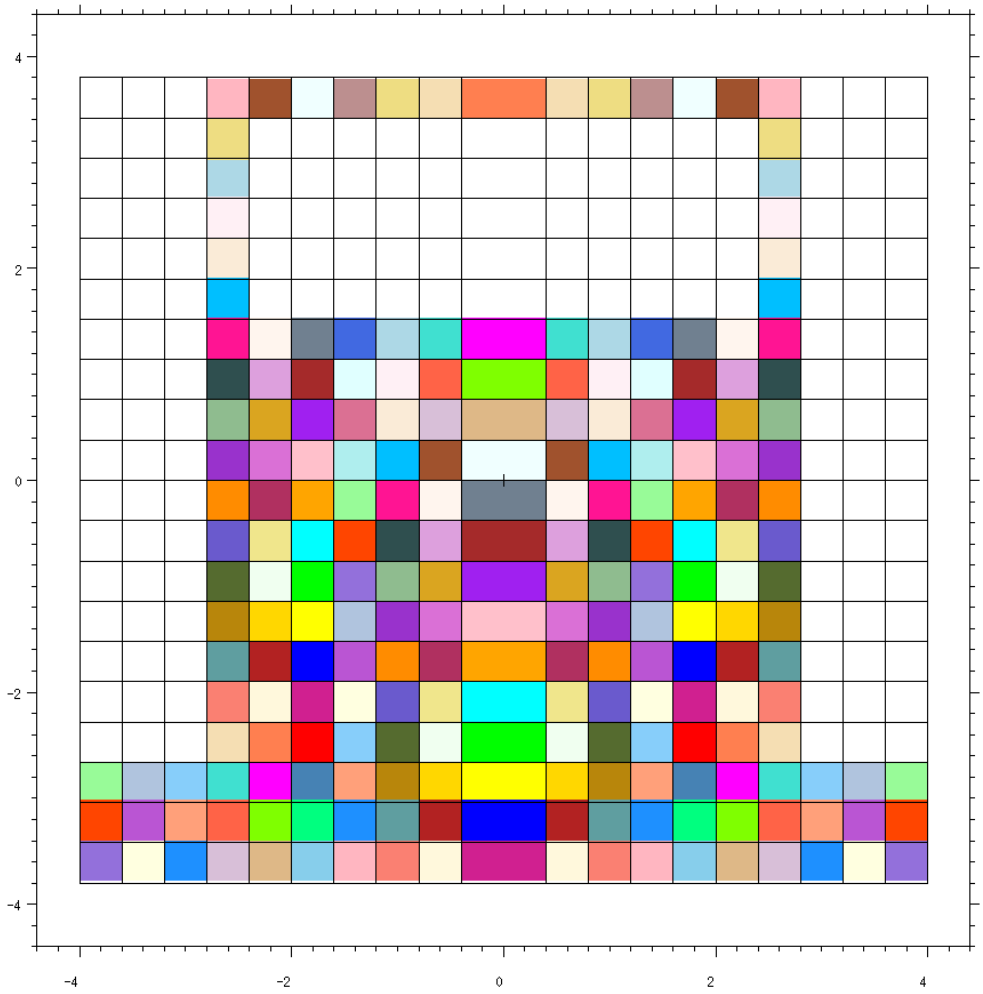

Figure 2. Cross-section (*r*-*z*) of the MCNP6 `lnk3dnt` cylindrical geometry. Scales in centimeters.

III.A.5. Results for Test 2

Both input files gave exactly the same k_{eff}, 3.3483603E-03.

Comparing the cross-section sensitivities from the regular SENSMG input and the `redoin/lnk3dnt` input (step 5), a few are different in the last (sixth) digit after the decimal. The comparison uses the isotope totals because the `redoin/lnk3dnt` capability only computes isotope totals, rather than sensitivities of isotopes in each mesh.

Comparing the mass density sensitivities from the regular SENSMG input and the `redoin/lnk3dnt` input (step 7), a few are different in the last (sixth) digit after the decimal.

Comparing the surface derivatives from the regular SENSMG input and the `redoin/lnk3dnt` input (step 6), most of them are identical. There are three small values (e.g. 10^{-12}) that differ in the third digit after the decimal, but even then the relative difference is within 0.04%. (There are many even smaller values that differ less.) There are also several values that are different in the last or second-to-last (fifth or sixth) digit after the decimal.

Because MCNP6 mixes materials in a mesh by random sampling,[4] it does not write consistent densities to the lnkout file. Even when the mesh was set up to align with the material interfaces (so that no materials are mixed), the same material appeared at various densities. The formula for the adjoint-based derivative of a response with respect to an interface location involves differences of macroscopic cross sections across the interface.[1] Therefore, the `redoin/lnk3dnt` input from MCNP6 results in many nonzero derivatives that should be zero and are zero with the regular SENSMG input. These nonzero values are very small: none is greater in magnitude than 10^{-17}.

III.A.6. Procedure for Test 3

Finally, the capability was tested with a `redoin/lnk3dnt` setup that defined a separate material in each fine mesh, as shown in Figure 3. The `lnk3dnt` file for this geometry was written with an auxiliary code according to the file format given in Ref. 3. Results were compared with those from a regular SENSMG input that specified the problem as normal, with materials defined in coarse meshes as shown in Figure 1, and a regular but finely-discretized SENSMG input that specified the problem using the same mesh that the `redoin/lnk3dnt` capability sets up (Figure 3). There are 1500 meshes, 1000 of which have material in them. Sensitivities from the three inputs should be identical.

The procedure was as follows:

1. Run the initial, regular SENSMG input file to completion. Save all output.
2. Save the `redoin` file and modify it as follows:
    a. In block_1, set `im` equal to `it` and `jm` equal to `jt`.
    b. In block_1, set `mt` equal to the number of isotopes.
    c. In block_1, set `nzone` equal to the new `mt` (the number of isotopes).
    d. Remove the entries in "`&block_2`" (leaving "`&block_2`").
    e. Remove the entries in "`&block_2_arrays`" (leaving "`&block_2_arrays`").
    f. In block_4_arrays, change `matspec` to `matspec="atdens"` (including the quotation marks; see appendix for format).

g. In block_4_arrays, change `assign` to `assign="matls"` (including the quotation marks; see appendix for format).
h. In block_4_arrays, change `matls` to list each isotope with an atom density of 1. (see appendix for format).

Note that the resulting file is not a legitimate PARTISN input file, but it is good enough because. SENSMG reads it and constructs from it a legitimate PARTISN input file.

3. Run the original SENSMG file and write a `lnk3dnt` file from its data using subroutine wrdantlnk called from the main program, sensmg. The new `lnk3dnt` file is called `tmp_lnk3dnt`. Save it.
4. Run to completion SENSMG with the `redoin` file modified in step 2 and the `lnk3dnt` file created in step 0.
5. Compare the cross section sensitivities in `sens_k_x` from steps 1 and 4. They should be identical.
6. Compare surface derivatives in `sens_k_r` from steps 1 and 4 for the boundaries between materials and the outer boundary. They should be identical.
7. Compare some of the mass density sensitivities in `sens_k_r` from steps 1 and 4. They should be identical.

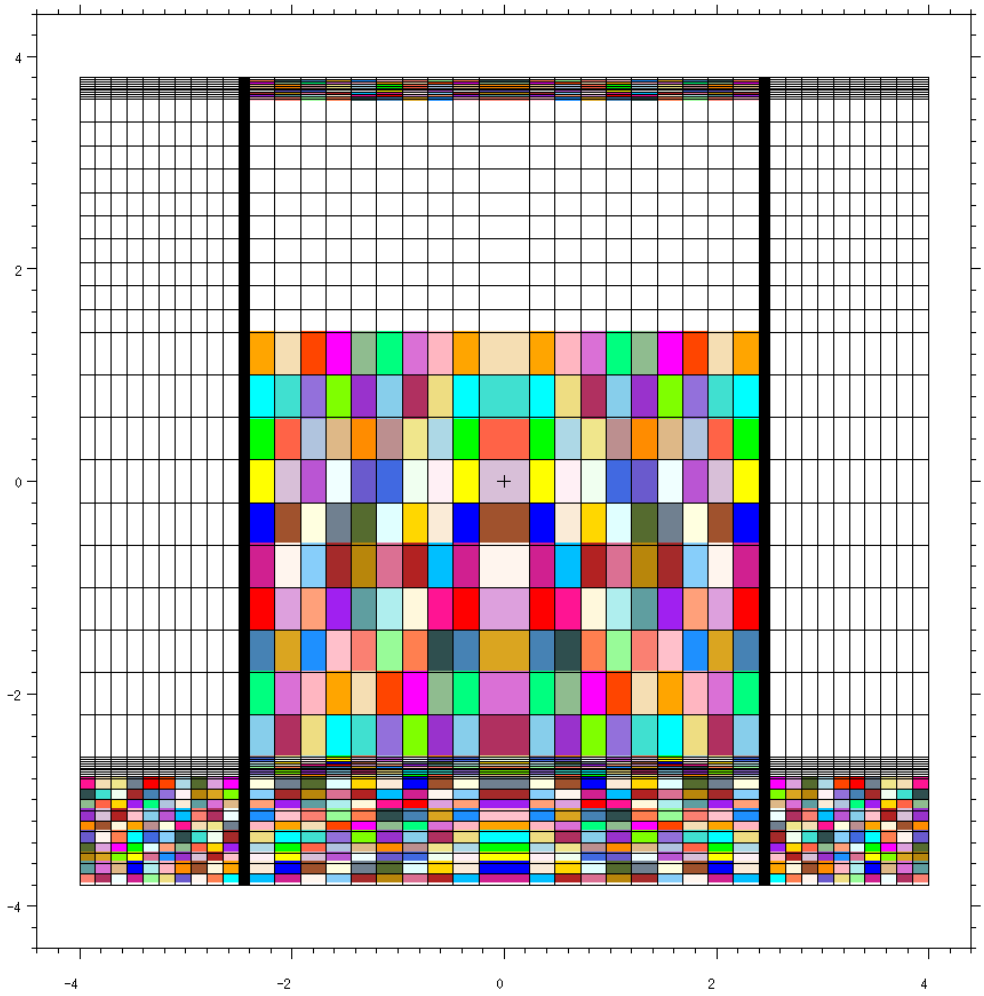

Figure 3. Cross-section (*r*-*z*) of the finely-discretized cylindrical geometry. Scales in centimeters.

8. Run the `redoin` file modified in step 2 and the `lnk3dnt` file created in step 0 and write a new, finely-discretized SENSMG input file using subroutine wrsensmg called from the main program, sensmg. The new SENSMG input file is called `tmp_sensmg_inp`. Save it.
9. Run to completion SENSMG with the SENSMG input file created in step 8.
10. Compare some of the cross section sensitivities in `sens_k_x` from steps 4 and 9. They should be identical.
11. Compare the surface derivatives in `sens_k_r` from steps 4 and 9. They should be identical.
12. Compare the mass density sensitivities in `sens_k_r` from steps 4 and 9. They should be identical.

In this procedure, there were three input files run in SENSMG. The input file run in step 1 is the same as that run in step 1 of Sec. III.A.2. It listed in the appendix. It was run with 10 fine meshes in each coarse mesh in each direction. These were set by modifying the source code for this test. The goal was to run quickly, not accurately. The `redoin` file as modified in step 2 is listed in the appendix.

The finely-discretized SENSMG input file created in step 8 is over 1000 lines long (there is, for example, one line for each material[2]) and is not listed in the appendix. It was run using 1 fine mesh in each coarse mesh in each direction, again by modifying the source code for this test.

III.A.7. Results for Test 3

All three input files gave exactly the same k_{eff}, 3.3626593E-03.

Comparing the cross-section sensitivities from the regular SENSMG input and the `redoin`/`lnk3dnt` input (step 5), they are identical except for differences in the sum of the chi sensitivities that are supposed to be zero but are numerically only very small (e.g. 4E-18). The individual group components of the chi sensitivities are all identical.

Comparing the surface derivatives from the regular SENSMG input and the `redoin`/`lnk3dnt` input (step 6), they are almost identical. This comparison required summing the appropriate `redoin`/`lnk3dnt` derivatives to match the surfaces on Figure 3 with the corresponding ones on Figure 1. A few of the values have differences in the last (sixth) digit after the decimal.

Comparing the mass density sensitivities from the regular SENSMG input and the `redoin`/`lnk3dnt` input (step 7), they are identical. This comparison required summing the appropriate `redoin`/`lnk3dnt` sensitivities to match the regions on Figure 3 with the corresponding ones on Figure 1.

Comparing the cross-section sensitivities from the finely-discretized SENSMG input and the `redoin`/`lnk3dnt` input (step 10), they are almost identical. A few are different in the last (sixth) digit after the decimal. The comparison uses the isotope totals because the `redoin`/`lnk3dnt` capability only computes isotope totals, rather than sensitivities of isotopes in each mesh.

Comparing the surface derivatives from the finely-discretized SENSMG input and the `redoin`/`lnk3dnt` input (step 11), both groupwise and group totals, they are identical.

Comparing the mass density sensitivities from the finely-discretized SENSMG input and the `redoin`/`lnk3dnt` input (step 12), both groupwise and group totals, they are identical.

IV. Summary and Future Work

The SENSMG multigroup neutron sensitivity code can now read materials and geometry from `redoin` and `lnk3dnt` files. These may be written by PARTISN or MCNP6 (these codes write `lnk3dnt` files as standard features[3,4]) or by any code as long as the format (as defined in Chapter 11 of the PARTISN manual[3]) is correct.

The capability does not yet work with fixed-source problems. The difficulty is that, in general, a `lnk3dnt` mesh mixes adjacent materials, and the resulting material will have the same isotope replicated for each material in which it appears. The ideal way to handle this would be to keep the material definition with replicated isotopes and keep track of the contribution to each material that they came from. However, the codes that SENSMG uses to compute intrinsic neutron sources, MISC (Ref. 7) and SOURCES4C (Ref. 8), cannot yet handle replicated isotopes in a material. We are considering how to handle this issue.

The SENSMG manual[2] will be updated to include Sec. II of this report.

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APPENDIX A
INPUT FILES FOR THE TEST PROBLEM

Original SENSMG Input for Test 1 and Test 3

```
knowles, high-density solution
cyl keff
mendf71x
3 / no. of materials
1 92235 0.000033959 92238 0.00996604 8016 0.883106 1001 0.106894 / depleted uranium solution
2 1001 0.143716 6000 0.856284 / polyethelene
3 13027 1.0 / shield
10.25 0.93 2.7 /
3 5 / number of cylinders, number of layers
2.4 2.5 4 / radii
0.0 1.0 1.2 5.2 7.4 7.6 / heights, bottom to top
 2 2 0 / material map, top layer
 0 2 0 / material map, next layer
 1 2 0 / material map, next layer
 2 2 0 / material map, next layer
 3 3 3 / material map, bottom layer
 0  0       / index of coarse mesh to use for reaction rates
 0          / number of reaction-rate ratios
```

REDOIN Input File for Test 1
This file is not a valid PARTISN input, but it is a valid SENSMG input.

```
     3     0     0     1     0
knowles, high-density solution
knowles
 forward input file, keff

&block_1
   b1_inputs=12
   iquad=6
   jm=5
   niso=0
   maxscm=600000000
   jt=50
   it=30
   mt=3
   im=3
   isn=16
   nzone=3
   ngroup=30
   igeom="r-z"
/

&block_2
/
&block_2_arrays
/

&block_3
   b3_inputs=6
   libname="mendf71x"
   fissdata=0
   lib="ndilib"
   fissneut=1
   lng=30
   ebound_size=31
/
&block_3_arrays
   ebound=
      1.700000E+01  1.500000E+01  1.350000E+01  1.200000E+01  1.000000E+01  7.790000E+00  6.070000E+00
3.680000E+00  2.865000E+00  2.232000E+00
      1.738000E+00  1.353000E+00  8.230000E-01  5.000000E-01  3.030000E-01  1.840000E-01  6.760000E-02
2.480000E-02  9.120000E-03  3.350000E-03
```

```
      1.235000E-03  4.540000E-04  1.670000E-04  6.140000E-05  2.260000E-05  8.320000E-06  3.060000E-06
1.130000E-06  4.140000E-07  1.520000E-07
      1.390000E-10
/

&block_3_xsec
/

&block_4
   b4_inputs=3
   matspec_size=3
   matls_size=7
   assign_size=3
/
&block_4_arrays
   matspec=
      "wtfrac"
      "wtfrac"
      "wtfrac"
   matls=
      "m000001" "92235.711nm" 3.3959000E-05
      "m000001" "92238.711nm" 9.9660400E-03
      "m000001" "8016.710nm" 8.8310600E-01
      "m000001" "1001.710nm" 1.0689400E-01
      "m000002" "1001.710nm" 1.4371600E-01
      "m000002" "6000.710nm" 8.5628400E-01
      "m000003" "13027.710nm" 1.0000000E+00
   assign=
      "zn000001" "m000001" 10.25000000
      "zn000002" "m000002" 0.93000000
      "zn000003" "m000003" 2.70000000
/

&block_5_int
   b5_inputs=16
   nofxup=1
   ith=0
   cellsol=1
   raflux=0
   xsectp=2
   ievt=1
   rmflux=1
   oitm=9999
   balp=0
/
&block_5_real
   epsi=1.00E-03
   norm=1.0
/
&block_5_char
/
&block_5_sizes
   isct_size=1
   iitl_size=1
   iitm_size=1
   afluxx_size=3
   afluxy_size=6
/
&block_5_arrays
   isct=
      3
   iitl=
      0
   iitm=
      999
   afluxx=
      11  21  31
   afluxy=
      1  11  21  31  41  51
/

&block_6
   b6_inputs=7
   igrped=0
```

```
   zned=1
   ajed=0
   edmats_size=3
   rsfnam_size=1
   edxs_size=20
   rsfe_size=30
/
&block_6_arrays
   edmats=
    "m000001"
    "m000002"
    "m000003"
   rsfnam=
      "flux"
   edxs=
      "chi"
      "nusigf"
      "total"
      "abs"
      "chi"
      "(n,n)"
      "(n,n')"
      "(n,2n)"
      "(n,3n)"
      "(n,g)"
      "(n,p)"
      "(n,a)"
      "(n,f)"
      "(n,n')f"
      "(n,2n)f"
      "(n,F)"
      "chi_pr"
      "chi_tot"
      "(n,d)"
      "(n,t)"
   rsfe=
      1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
      1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
      1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
/
```

MCNP6.2 Input File for Test 2

```
knowles problem, high-density solution
1   3    -2.700    -13 20 -21               imp:n=1
2   2    -0.930   (-12 21 -25) (11:-22:24)  imp:n=1
3   1    -10.25    -11 22 -23               imp:n=1
4   0              -11 23 -24               imp:n=1
5   0              -13 12  21 -25           imp:n=1
90  0              -99 (13:-20:25)          imp:n=1
99  0               99                      imp:n=0

11  cz   2.4
12  cz   2.5
13  cz   4.0
20  pz   0.
21  pz   1.
22  pz   1.2
23  pz   5.2
24  pz   7.4
25  pz   7.6
99  so 100.

mode n
mesh  geom=rzt origin=0. 0. 0. axs=0. 0. 1. vec=1. 0. 0.
      ref=0. 0. 3.
c     imesh= 2.4 2.5 4.0          iints=10 10 10
c     jmesh= 1.0 1.2 5.2 7.4 7.6  jints=10 10 10 10 10
      imesh= 4.0                  iints=10
      jmesh= 7.6                  jints=20
      kmesh= 1.                   kints=1
dawwg points=10
```

```
      block=1 isn=16 ngroup=30 fmmix=1
      block=3 libname=mendf71x fissneut=1
      block=5 ievt=1 trcor=no diffsol=mg
              isct=3 epsi= 1.00E-03 norm=1.0 rmflux=1 oitm=9999 iitm=999
              $ nofxup=1 iitl=0
sdef
m1    92235 -0.000033959
      92238 -0.00996604
       8016 -0.883106001
       1001 -0.106894
m2     1001 -0.143716
       6000 -0.856284
m3    13027 -1.0
c
print -30
```

PARTISN Input File for Test 2

```
     5     0     0     0     0
knowles problem, high density solution
****************************************************
* Input autogenerated by MCNP                      *
* Input for PARTISN kcode run for comparison to MCNP  *
****************************************************
/ *********************************************
/ Block I ... Dimensions and Controls ...
    igeom= r-z
    nzone=       3
       im=      10
       it=      10
       jm=      20
       jt=      20
       km=       1
       kt=       1
   ngroup=      30
      isn=      16
     niso=       0
       mt=       3
    iquad=       6
    fmmix=       1
 t
/ *********************************************
/ Block III ... Nuclear Data Type and Options ...
 fissneut=       1
      lib= ndilib
  libname= mendf71x
 t
/ *********************************************
/ Block IV   ... Cross-Section Mixing ...
 matspec=wtfrac
         wtfrac
         wtfrac
 matls=
        m000001
            "92235.711nm"  3.3959000E-05
            "92238.711nm"  9.9660400E-03
             "8016.710nm"  8.83106001E-01
             "1001.710nm"  1.0689400E-01;
        m000002
             "1001.710nm"  1.4371600E-01
             "6000.710nm"  8.5628400E-01;
        m000003
            "13027.710nm"  1.0000000E+00;
 assign=
        zn000001   m000001    1.;
        zn000002   m000002    1.;
        zn000003   m000003    1.;
 t
/ *********************************************
/ Block V ... Solver Input ...
     norm= 1.000E+00
     epsi= 1.000E-03
```

```
     ievt=       1
     isct=       3
     oitm=    9999
   rmflux=       1
     iitm=     999
    trcor= no
   srcacc= dsa
  diffsol= mg
 nofxup=1 iitl=0
 t
/ ******************************************
/ Block VI ... Edit Controls ...
  massed=     1
  edoutf=     3
 t
/ ******************************************
```

REDOIN Input File for Test 2
This file is not a valid PARTISN input, but it is a valid SENSMG input.

```
     5     0     0     1     0
knowles problem, high density solution
*********************************************************
* Input autogenerated by MCNP                           *
* Input for PARTISN kcode run for comparison to MCNP  *
*********************************************************

&block_1
   b1_inputs=14
   iquad=6
   niso=0
   mt=3
   jt=20
   it=10
   km=1
   jm=20
   fmmix=1
   im=10
   isn=16
   ngroup=30
   kt=1
   nzone=3
   igeom="r-z"
/

&block_2
   b2_inputs=0
/
&block_2_arrays
/

&block_3
   b3_inputs=3
   fissneut=1
   libname="mendf71x"
   lib="ndilib"
/
&block_3_arrays
/

&block_3_xsec
/

&block_4
   b4_inputs=3
   matspec_size=3
   matls_size=7
   assign_size=3
/
&block_4_arrays
   matspec=
```

```
      "wtfrac"
      "wtfrac"
      "wtfrac"
   matls=
      "m000001" "92235.711nm" 3.3959000E-05
      "m000001" "92238.711nm" 9.9660400E-03
      "m000001" "8016.710nm" 8.83106001E-01
      "m000001" "1001.710nm" 1.0689400E-01
      "m000002" "1001.710nm" 1.4371600E-01
      "m000002" "6000.710nm" 8.5628400E-01
      "m000003" "13027.710nm" 1.0000000E+00
   assign=
      "zn000001" "m000001" 1.
      "zn000002" "m000002" 1.
      "zn000003" "m000003" 1.
/

&block_5_int
   b5_inputs=12
   oitm=9999
   nofxup=1
   rmflux=1
   ievt=1
/
&block_5_real
   epsi=1.000E-03
   norm=1.000E+00
/
&block_5_char
   diffsol="mg"
   trcor="no"
   srcacc="dsa"
/
&block_5_sizes
   isct_size=1
   iitl_size=1
   iitm_size=1
/
&block_5_arrays
   isct=
      3
   iitl=
      0
   iitm=
      999
/

&block_6
   b6_inputs=2
   edoutf=3
   massed=1
/
&block_6_arrays
/
```

REDOIN Input File for Test 3
This file is not a valid PARTISN input, but it is a valid SENSMG input.

```
     3     0     0     1     0
knowles, high-density solution
knowles
 forward input file, keff

&block_1
   b1_inputs=12
   iquad=6
   jm=50
   niso=0
   maxscm=600000000
   jt=50
   it=30
   mt=7
```

```
   im=30
   isn=16
   nzone=7
   ngroup=30
   igeom="r-z"
/

&block_2
/
&block_2_arrays
/

&block_3
   b3_inputs=6
   libname="mendf71x"
   fissdata=0
   lib="ndilib"
   fissneut=1
   lng=30
   ebound_size=31
/
&block_3_arrays
   ebound=
      1.700000E+01  1.500000E+01  1.350000E+01  1.200000E+01  1.000000E+01  7.790000E+00  6.070000E+00
3.680000E+00  2.865000E+00  2.232000E+00
      1.738000E+00  1.353000E+00  8.230000E-01  5.000000E-01  3.030000E-01  1.840000E-01  6.760000E-02
2.480000E-02  9.120000E-03  3.350000E-03
      1.235000E-03  4.540000E-04  1.670000E-04  6.140000E-05  2.260000E-05  8.320000E-06  3.060000E-06
1.130000E-06  4.140000E-07  1.520000E-07
      1.390000E-10
/

&block_3_xsec
/

&block_4
   b4_inputs=3
   matspec_size=3
   matls_size=7
   assign_size=3
/
&block_4_arrays
   matspec=
      "atdens"
   matls=
      "m000001" "92235" 1.
      "m000002" "92238" 1.
      "m000003" "8016" 1.
      "m000004" "1001" 1.
      "m000005" "1001" 1.
      "m000006" "6000" 1.
      "m000007" "13027" 1.
   assign=
      "matls"
/

&block_5_int
   b5_inputs=16
   nofxup=1
   ith=0
   cellsol=1
   raflux=0
   xsectp=2
   ievt=1
   rmflux=1
   oitm=9999
   balp=0
/
&block_5_real
   epsi=1.00E-03
   norm=1.0
/
&block_5_char
/
```

```
&block_5_sizes
   isct_size=1
   iitl_size=1
   iitm_size=1
   afluxx_size=3
   afluxy_size=6
/
&block_5_arrays
   isct=
      3
   iitl=
      0
   iitm=
      999
   afluxx=
      11  21  31
   afluxy=
      1  11  21  31  41  51
/

&block_6
   b6_inputs=7
   igrped=0
   zned=1
   ajed=0
   edmats_size=3
   rsfnam_size=1
   edxs_size=20
   rsfe_size=30
/
&block_6_arrays
   edmats=
    "m000001"
    "m000002"
    "m000003"
   rsfnam=
      "flux"
   edxs=
      "chi"
      "nusigf"
      "total"
      "abs"
      "chi"
      "(n,n)"
      "(n,n')"
      "(n,2n)"
      "(n,3n)"
      "(n,g)"
      "(n,p)"
      "(n,a)"
      "(n,f)"
      "(n,n')f"
      "(n,2n)f"
      "(n,F)"
      "chi_pr"
      "chi_tot"
      "(n,d)"
      "(n,t)"
   rsfe=
      1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
      1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
      1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
/
```